the first moving across from the 21st to 24th, and the second on the 26th and 27th. Warnings of these two cold waves were issued well in advance of their approach.

Vesselmen on Lake Michigan were kept fully informed as to the expected movement of storms during the month, and no casualty from stress of weather has been reported.—*H. J. Cox, Professor.*

SAN FRANCISCO FORECAST DISTRICT.

From the 2d to the 7th, inclusive, warnings of severe frosts, probably injurious to citrus fruit in exposed places, were issued throughout California. These warnings were fully verified, all Weather Bureau stations reporting heavy or killing frosts on those dates. The usual precautions were taken in the citrus belt to prevent injury, and it is believed that no damage was sustained. There were no important conditions which were not forecasted in due time.—*G. H. Willson, Local Forecast Official.*

PORTLAND, OREG., FORECAST DISTRICT.

River forecasts were issued on the 6th, 7th, 8th, 9th, and 10th, and were most favorably commented upon by people along the water front. The feature of the month was the cold period from the 1st to the 8th. Temperatures of zero and slightly below were reported from a few of the more exposed places west of the Cascades, and zero temperatures were general east of them. In portions of Washington, Oregon, and Idaho the lowest temperature on record was observed; this was especially true in the region about Baker City, Oreg. The accuracy of the forecast during this period was made the subject of much favorable comment. During the last half of the month much damage to grain and orchards was reported; the damage was not, however, as great as estimated. The unusual severity of the weather of the month caused a great demand for information upon the local office.—*B. S. Pague, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

During the month there were six highs and nine lows sufficiently well defined to be traced on Charts I and II. In these charts the center of each circle represents the position of the high or low on the date and hour inscribed within. There is also entered in the circle the reading of the barometer near the center. In many cases this reading is quite approximate, especially when the high or low is on the border of the observation region. It should also be noted that sometimes the center has been located by the direction of the winds about it, and not necessarily by the highest or lowest reading of pressure. This is especially the case in the mountain and Plateau regions.

The principal facts regarding the date and place of first and last appearance, the duration, and velocity of these highs and lows are given in the accompanying table, and the following remarks are added:

Highs.—The month has been remarkable in a good many respects. Nearly the highest pressure ever observed in the United States and Canada, 31.42 inches, was reported at Swift Current on the morning of the 11th, and this was a reinforcement of a high area that had been nearly stationary there, or stretching in a ridge of high pressure in a southeast direction to the middle Mississippi Valley since the morning of the 6th. In connection with this ridge of high pressure extremely low temperature was noted in a rather narrow strip from Montana to the middle Atlantic coast. At Washington a temperature of 15° below zero was experienced at 8 a. m. of the 11th, which was 1° below the lowest ever noted by the Weather Bureau, and this was a radiation cold rather than the cold of a cold wave.

All the highs were first noted to the north of Montana and moved in a southeast direction to the Mississippi Valley, and thence east and northeast to the Atlantic coast. Numbers I and V disappeared off the south Atlantic, II off the middle Atlantic, and the remaining three could be traced to Newfoundland. The severe temperature conditions of the month were mostly in the first half, and were prevalent more in the Southern and Western States than in the Northeast States; at 8 p. m. of the 1st Denver reported a fall in temperature of 48° in twenty-four hours and to —4°, but this cold wave had practically disappeared by the next a. m.; at 8 a. m. of the 7th, in connection with the ridge of high pressure noted above, there was quite a sharp fall in temperature in the middle Gulf States; Mobile had 30° fall in twenty-four hours. This cold spell culminated in Florida at 8 p. m. of the 8th. Jacksonville reported a fall of 40° at 8 a. m. of the 9th. In connection with same ridge the Middle Atlantic States experienced decidedly low temperatures. Atlantic City and New York had a fall of 32°, and Washington a temperature of —6°. The low temperature of this period continued till a. m. of the 11th; at 8 a. m. of 10th Washington reported —8°, and the next morning, —15°.

At 8 p. m. of the 11th, as high III approached the middle Mississippi Valley, Amarillo and Oklahoma reported a fall of 40°, and to —10° and 4°, respectively, and the next a. m. Galveston had a fall of 32° and to 10°. This cold wave moved eastward with the high area, and culminated in Florida on the 13th; at 8 a. m. Jacksonville reported a fall of 38° and to 10°.

As high No. V moved to the middle Mississippi Valley sharp falls in temperature occurred in the Missouri Valley; Moorhead reported a fall of 28°, and to —4° at p. m. of the 26th; at 8 a. m. of the 27th this cold wave reached the lower Lake region, Cleveland reporting a fall of 28° and to 26°.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	*29, a. m.	54	109	2, a. m.	33	78	2,700	4.0	675	28.1
II	7, a. m.	52	108	11, p. m.	41	76	1,980	4.5	440	18.3
III	9, p. m	50	116	17, a. m.	47	56	5,370	7.5	716	29.8
IV	21, p. m.	52	117	27, a. m.	46	58	3,660	5.5	665	27.7
V	24, p. m.	53	118	28, p m.	32	77	2,780	4.0	682	28.4
VI	27, a. m.	53	110	†3, a. m.	47	59	2,910	4.0	728	30.3
Total							19,350	29.5	3,906	162.6
Mean of 6 paths							3,225		651	27.1
Mean of 29.5 days									656	27.3
Low areas.										
I	1, a. m.	47	126	4, p. m.	45	54	4,470	3.5	1,277	53.2
II	3, p. m.	29	101	6, a. m.	36	75	1,740	2.5	696	29.0
III	5, p. m.	28	95	9, p. m.	49	54	2,790	4.0	697	29.0
IV	8, p. m.	30	107	14, p. m.	48	53	3,690	6.0	615	25.6
V	13, a. m.	32	116	17, a. m.	39	70	2,910	4.0	728	30.3
VI	14, p. m.	51	117	19, p. m.	46	59	2,790	5.0	558	23.3
VII	20, p. m.	37	98	24, a. m.	48	56	2,460	3.5	703	29.3
VIII	23, a. m.	32	115	28, a. m.	47	59	3,420	5.0	684	28.5
IX	26, p. m.	48	124	†1, a. m.	50	62	3,090	2.5	1,236	51.5
Total							27,360	36.0	7,194	299.7
Mean of 9 paths							3,040		799	33.3
Mean of 36 days									760	31.7

*January. †March.

Lows.—Three of the storms were first noted on or near the north Pacific coast, and three more on the south Pacific coast, the remaining three in the west Gulf. The general motion was toward the east and northeast. Seven of the storms dis-

appeared over Newfoundland, and two, No. II and No. V, off the middle Atlantic coast. High winds occurred as follows: At 8 a. m. of 8th, as low No. III approached the New England coast, Block Island reported an east wind of 66 miles an hour. During the 13th, as No. IV moved up the Atlantic coast, Hatteras and Sandy Hook experienced north winds of 60 miles, and the same afternoon Block Island had a north wind of 72 miles, Sandy Hook northwest 60, Boston east 52, Hatteras west 50, Eastport northeast 48, and a northwest wind of 48 miles occurred at Atlantic City, Cape May, and Cape Henry; at 8 a. m. of the 26th, as No. VIII approached upper Lake region (the only severe storm of the month in the Lake region), Chicago reported a south wind of 48 miles.—*H. A. Hazen, Professor.*

RIVERS AND FLOODS.

The Mississippi River remained frozen during the entire month to below Hannibal. From the mouth of the Illinois southward, and in the Missouri east of Kansas City, the stage of water varied but slightly until the 26th and 27th when there was rise of 2 or 3 feet, owing to the heavy rains of the 25th and 26th. The Missouri also remained frozen north of Kansas City, and was likewise frozen at Kansas City from the 1st to the 17th, inclusive.

Rains on the 20th caused a rise to set in along the Ohio, but not to an alarming extent. The crest passed Pittsburg on the 23d, Wheeling on the 24th, Parkersburg on the 25th, Cincinnati on the 27th, and Louisville on the 28th.

In the lower Mississippi the crest of the January rise reached New Orleans on the 3d, but nothing of importance occurred during the month.

The heavy rains of the 3d and 4th resulted in a great rise in the Tennessee and Cumberland rivers. At Carthage, Tenn., on the Cumberland, the water rose 35.2 feet from the 3d to the 8th, reaching 41.7 feet, or 11.2 feet above the danger line. At Nashville the danger line of 40 feet was exceeded by 0.8 foot on the 11th. No losses or damage worth mentioning occurred.

In the Tennessee, however, a very different state of affairs prevailed. The rains were much heavier along this watershed and the rivers generally rose above danger lines, except at Knoxville.

The following extracts relative to this flood are taken from the special report of Mr. L. M. Pindell, Official in charge of the United States Weather Bureau office at Chattanooga, Tenn.:

Heavy rains (3d to 5th) occurred over the Tennessee River watershed, producing a sudden rise of 13 feet in twenty-four hours in the Hiawassee River; 14 feet in the Clinch River at Speers Ferry; 7 feet in the Tennessee at Knoxville, and 3.5 at Chattanooga. On the morning of the 4th the river forecast stated that the Hiawassee would rise slowly Saturday night and Sunday (4th and 5th); the Clinch would rise rapidly Saturday night and slower Sunday, and the Tennessee rapidly till Sunday morning, and slower Sunday afternoon and night, reaching about 20 feet at Chattanooga by Sunday night or Monday morning. Heavy drift began passing down by night of the 4th, with the river rising at the rate of three and one-half tenths per hour. On the morning of the 5th (Sunday), heavy rains with thunderstorms having occurred during the preceding twenty-four hours, and the river having reached the stage of 20 feet ten hours sooner than forecast, with the rise still continuing at the rate of seven and one-half tenths per hour, special reports were called for from the upper river and the following forecasts issued:

"The river (at Chattanooga) will reach 29 feet by Monday morning (actual stage reached, 29.5 feet); the crest from the Clinch will produce a second rise here, and the river will probably reach the danger line Monday night or Tuesday."

River men were notified to protect all property under the 33-foot mark.

As the rains continued, the following supplementary forecast was issued on the morning of the 6th (Monday):

"The Tennessee will continue to rise, reaching the 35-foot stage by Tuesday afternoon. From data in hand at the present time it seems probable that the crest rise will not exceed 37 feet."

On the 7th the forecast stated that the river at Chattanooga would rise steadily, reaching about 38 feet on Wednesday morning (8th). Warnings of this probable 38-foot stage at Chattanooga were also telegraphed to different points as far as Cairo.

Business men were quite uneasy about their goods in cellars, and some were advised to move their stock, which they did, and in no case was unnecessary expense incurred by the merchants. Poor people living in the lowlands consulted the office frequently. Some were advised to move, and others advised to remain and consult the office again on Wednesday morning, as ample notice and time would be given them. No one moved unnecessarily, as was proven afterward by the crest stage attained. The 3 p. m. special bulletin of the 7th showed all rivers rising except the Clinch at Clinton, Tenn., and the following forecast was issued:

"The river will continue to rise to-night, and slower Wednesday. The stage Wednesday morning will be between 37 and 38 feet. The crest rise will occur sometime between Wednesday night and Thursday morning, and will not exceed 40 feet."

The cold wave checked the rise, and at 3 p. m. of the 8th (Wednesday) advisory messages of a falling river were issued. It is estimated that the severely cold weather prevented an additional rise of at least 2 feet.

The property loss from the flood was comparatively small, and none happened that could have been avoided.

Navigation was impeded by heavy drift from the 5th to 10th, and by heavy floating ice from Knoxville to Chattanooga from the 13th to the 16th.

The forecasts were gratifyingly accurate, and the Official in charge at Chattanooga received many exceedingly commendatory notices relative to the work of the Weather Bureau. At Knoxville property to the value of $90,000 was removed and saved. The value of that saved at other places can not be estimated.

The melting of the snow and ice at the headwaters of the Tennessee produced a splendid logging stage, and about 9,500,000 feet of logs were rafted down the river by the end of the month.

At the close of the month the river was again rising on account of heavy rains, and another 20-foot stage was indicated on March 1.

The James River was also in flood from the 17th to 21st, inclusive, particularly in the vicinity of Richmond, and a detailed account by Mr. E. A. Evans, Official in charge of that station, follows:

It is probable that the history of this flood will never be written in a manner which will set forth its various phases exactly as they occurred, or without exaggeration or underestimation. The length of time during which it presented threatening conditions, as well as its rapidly changing aspects, combine to prevent full, accurate justice being done it.

On account of the unusual conditions prevailing for several days prior to the flood, it is deemed advisable, as necessary to a full understanding of subsequent events, to summarize them briefly.

From the beginning of the month the weather was stormy, days with freezing rain, sleet, and snow succeeding each other at short intervals, until the great sleet storm of the 5th to 7th, which, in its turn, was followed on the 11th by a snowstorm lasting fifty-four consecutive hours, and causing a depth on a level of 16 inches, or a total amount of unmelted precipitation on the ground at 8 p. m of the 14th of about 18 inches, inclusive of that which was in evidence prior to the beginning of the blizzard. And neither the sleet nor snow was local, but prevailed with equal energy over the entire basin of the James. At the same time the temperatures ranged unusually low for this section during the period from the 1st to the 17th, with the exception of the 4th to 8th, when they were about normal. Thus both temperature and precipitation seemed to unite to build up by degrees a situation which was pregnant with danger, and which only awaited the coming of rising temperature, thawing southerly winds, and warm rains to materialize from a possibility to an actuality; from an indicated to a present danger. These then were the conditions obtaining up to the morning of the 16th, and it is needless to say that they were regarded with increasing anxiety by this office. As early as the 12th, while the snowstorm was still raging, advisory information was sent out to the various transportation companies, steamboat lines, and individual and corporate interests liable to injury, giving the existing and expected river conditions, and suggesting that all heavy material, freight, etc., be moved to places of safety. From time to time after this date and up to the 16th additional precautionary advice along the same line was issued.

Early in the morning of the 16th, or more precisely, at 7:30 a. m., rain set in with warmer weather, and the unlocking of the frozen